PATAFEST

PRACTICE ABSTRACT

Molecular modeling principles and application for the surveillance, detection, and control of potato plant pests

Pests, including specific insects, fungi, viruses, and bacteria, pose a significant threat to potato crops globally, causing substantial agricultural losses. These losses impact the economy and threaten food security and farmers' livelihoods. This project aims to address this issue by integrating phylogeographic data, which is the study of the geographical distribution of species, with molecular modeling techniques.

Our approach uses historical pest distribution data, enhancing the system's adaptability to environmental changes. We have developed a predictive dataset that allows for more accurate identification of potential pest outbreak hotspots. This dataset supports tailored management practices to mitigate specific threats.

By merging historical geographic data with advanced molecular dynamics, we have established a standardized system for pest surveillance. This integration has significantly improved the prediction of pest occurrences and the efficacy of control strategies. However, we have not quantified these improvements yet, which will be our focus for future work.

We encourage practitioners to use these insights to proactively refine their pest management strategies, thus increasing intervention effectiveness. Implementing this model promises reduced crop losses and a lower environmental footprint. However, the initial setup of the modeling system and stakeholder training represent the primary costs.

This project represents a significant step forward in pest management strategies. Future work will focus on quantifying the improvements brought about by this system and expanding its application to other crops.

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Pest and diseases potato resistance genes identification by using molecular biology methodologies, bioinformatics tools and biostatistical analyses

The aim is to establish a Potato Resistance Gene (Rgene) Catalogue and identify allelic variants based on integrated Single Nucleotide Polymorphism (SNP), protecting against post-harvest and the quarantine Zebra Chip diseases that could be used for breeding resistant potato varieties in the future.

Initially similarity searches (BLAST) were performed using different sources. First BLAST Searches for "*Solanum*" Resistance Genes using the Nucleotide and RefSeq databases at NCBI (National Center for Biotechnology Information) were conducted. Then search of "PLANT Resistance genes" using the Plant Resistance Gene Database (PRGdb) was performed. PRGdb Nucleotides and proteins were analysed. Finally, search of "Pathogen specific" Resistance genes was performed, targeting the project post-harvest pathogens and bacteria at Nucleotide DB of NCBI. In all approaches the identified sequences were downloaded and mapped against the Potato DM6.1 reference genome.

A total of 697 Rgenes were found to be already annotated on the reference genome. Many of them could be confirmed by sequence similarities from different sources. But also, numerous new DM6.1 genes without Rgene Annotation were identified, based on collocated resistance gene homologues from the different mentioned searches. A large amount of redundancy is currently present but will be eliminated in the next months and the detected Rgenes will be curated.

To analyze further allelic variants effects on disease resistance levels of the potato varieties through Association Mapping, all currently available Potato SNP (over 350,000 SNP) were compiled, mapped also to the DM6.1 genome and the SNP within Rgenes were identified. All analyses were supported by in-house developed Software.

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Cost effective diagnostic solutions for the early detection and surveillance of potato pest and diseases

Given the potential threat of emerging pests in agriculture, it is imperative to devise further strategies for preventing the spread, foment early detection, and monitor the presence of these pests.

With a special focus on potato farming, the aim is to develop cutting-edge digital technologies to control, on the one hand, the spread of the most important pest in the potato plant induced by bacteria *Candidatus* Liberibacter solanacearum (CLso) and responsible of the Zebra Chip (ZC) disease. And, on the other hand, to reduce the potato postharvest disease produced by the soil-borne pathogens *Fusarium sambucinum, Colletothricum coccodes,* and *Helminthosporium solani* by allowing early detection and surveillance of these pest and pathogen diseases.

To address preharvest threat, these cost-effective diagnostic solutions will consist of applied real-time diagnosis applying Artificial Intelligence strategies to potato plants and tuber health using high-performance and user-friendly portable sensors and smartphone apps. As a result of the product, a portable pest analysis system with real-time and low-cost diagnosis will be obtained.

A web application and a progressive web app tool based on the pictures obtained in the field and the laboratory will be built up which will act as a storage unit and data processing unit for the image analysis. The inserted data will be processed within the platform to generate an accurate response in terms of detection.

Then, for the postharvest storage in potato warehouses, a digital tool application and portable sensor devices based on Volatile Organic Compounds (VOCs) biomarkers from potatoes will be developed, with the capabilities of monitoring the environment.

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Sustainable solutions strategies as prevention tools to control potato pest and diseases

Presence of both a variety of pests and soil-borne pathogens are the main causes of diseases of potato crops causing significant economic losses, and consequently food losses. Although there are strict controls, globalisation, climate change and economical drivers are threatening the entrance of emerging or new potato pests from imported potato to EU.

Standard chemical pesticides are used to control pest and diseases to secure yields in plant production and reduce food wastage. However, possible consequences derived from the excessive use of chemical pesticides are the increase of the pesticide resistance in bacteria, insects, and soil-borne pathogens; the potential phytotoxicity effect on plant and products environmental contamination, and toxicity to non-target insects. Besides, the intense used of standard pesticides may cause consumer worries, prompting them to demand more environmentally friendly and chemical-free alternatives.

PATAFEST project aims to provide prevention strategies for potato plant, tubers, and soil health by developing and validating chemical free bio-based sustainable solutions as:

- Environmentally friendly wax sprays to provide anti-pathogenic properties and anti-adhesive performance against potato psyllids and aphids.
- Effective biocontrol coatings to reduce the incidence of some important postharvest pathogen diseases selected such as dry rot (*F. sambucinum*), black dot and silver scurf (*C. coccodes*, and *H. solani*, respectively) to ensure consumer safety and acceptance.
- Alternative biofertilizers obtained from the valorisation of aquaculture biomass to reduce susceptibility of potato plant to pathogens incidence both at foliar and tuber level.

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Potato pest and disease integrated pest management validation

The concept of Integrated Pest Management (IPM) is based on combining multiple control strategies and practices to effectively manage pests by minimizing the use of harmful chemicals and promoting sustainable agriculture.

Potato crops are threatened by the spreading of future and emerging pests. One of the most important pests is caused by the bacteria *Candidatus* Liberibacter solanacearum (CLso) responsible of zebra chip (ZC) disease. The introduction the CLso bacterium on potato is mainly linked to the presence of the vector psyllid *Bactericera cockerelli* (BC). Additionally, other threats (such as *Fusarium sambucinu*m, *Colletothricum coccodes*, *Helminthosporium solani*) also affect potato safety and quality during the postharvest activities, making the tubers unmarketable.

PataFEST project aims to provide a powerful European initiative for sustainable IPM strategies to treat and control the presence of CLso pest and its vector in plant and the incidence of several soil-borne pathogens in the potato postharvest storage.

Several IPM strategies will be implemented in PataFEST project testing previously identified resistance potato varieties; early detection and surveillance tools (mobile app and VOCs sensor); and natural sustainable solutions for plant, tubers, and soil.

In Ecuador, one IPM strategy will be carried out through field bioassay trials against CLso and its vector in potato plant under real conditions. On the other hand, in Europe IPM activities will be validated in specific relevant environments as Germany, France, Spain and the UK being the main potato producer countries.

Field and postharvest trial activities will involve the participation of potato packers, cooperative, trader and farmer associations.

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